



# Analysis of Acupoint Selection and Combinations in Acupuncture Treatment of Carpal Tunnel Syndrome: A Protocol for Data Mining

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**Background:** Carpal tunnel syndrome (CTS), as the most common compression neuropathy in the upper limb, can lead to upper limb dysfunction in patients. The effectiveness of acupuncture in treating CTS has been validated based on numerous clinical trials and meta-analyses, but questions remain, such as how to select the best acupoints. Our purpose is to conduct the first data mining analysis to identify the most effective acupoint selection and combinations for treating CTS.

**Methods:** We will search 7 electronic bibliographic databases (PubMed, Embase, Cochrane Library, China National Knowledge Infrastructure, Wanfang Database, Chinese Biomedical Literature Database and Chongqing VIP Database) from inception to March 2023. Clinical trials assessing the effectiveness of acupuncture therapy on the management of CTS will be selected. Reviews, protocols, animal trials, case reports, systematic reviews, and meta-analyses will be excluded. The primary outcome measure will be clinical result associated with CTS. Descriptive statistics will be performed in Excel 2019. Association rule analysis will be performed in SPSS Modeler 18.0. Exploratory factor analysis and cluster analysis will be performed in SPSS Statistics 26.0.

**Results:** This study will investigate the most effective acupoint selection and combinations for patients with CTS.

**Conclusion:** Our findings will provide evidence for the effectiveness and potential treatment prescriptions of acupoint application for patients with CTS, helping clinicians and patients make a more informed decision together.

**Keywords:** acupuncture, carpal tunnel syndrome, data mining, descriptive statistics, association rule analysis, exploratory factor analysis, cluster analysis

## Introduction

The carpal tunnel syndrome (CTS) is a wrist condition caused by compression of the median nerve, which often causes disabling and pain.<sup>1</sup> CTS is the most common compression neuropathy of the upper limb.<sup>2</sup> There is an annual prevalence of 2.7% to 6.7% of CTS.<sup>1,3</sup> People who are between the ages of 40 and 60 most often experience it, but people of all ages can suffer from it.<sup>4</sup> CTS at the wrist is commonly characterized by numbness, weakness, and dysesthesia in the hand(s). As a result, functional abilities are significantly limited.<sup>5</sup> The effects of CTS extend beyond the individual to affect society in ways, such as impairing performance at work or daily activities and thus increasing the medical costs. At present, an open carpal tunnel release is the gold standard treatment for CTS,<sup>6</sup> but this kind of surgical treatment has the risk of some complications.

Plenty of studies showed the effects of acupuncture therapy on relieving pain and improving functional status for CTS patients. Previous meta-analysis results showed that acupuncture is an effective method to treat CTS.<sup>7,8</sup> The choice of acupoints can vary according to different ideas and experiences of doctors. Acupoint selection and combinations are considered to be the core of the acupuncture treatment system.<sup>9</sup> Acupuncturists frequently amalgamate multiple

acupoints in clinical settings to augment the synergy between acupoints and ameliorate the therapeutic efficacy of acupuncture. The growing prevalence of effective acupuncture treatments for CTS has relied heavily on the implementation of numerous acupoint prescriptions. The efficacy of these prescriptions is intricately linked to the compatibility of meridians and acupoints, which presents a complex, contradictory, and uncertain relationship. Therefore, it is necessary to use existing data to analyze the principles of acupoint selection and combinations in order to develop the therapeutic potential of acupuncture. Data mining technology can help people find potentially useful information and knowledge in a large number of documents.<sup>10</sup> Based on these methods, previous studies investigated acupoint selection and combinations in acupuncture treatment of chronic stable angina pectoris,<sup>11</sup> obesity,<sup>12</sup> chemotherapy-induced peripheral neuropathy,<sup>13</sup> tic disorders,<sup>14</sup> and amyotrophic lateral sclerosis.<sup>15</sup> This study may provide evidence for the existence of specificity between the acupoints of different meridians and the fact that the benefits of acupuncture depend on the specificity of the acupoints. Therefore, it is of great significance to determine the characteristics and rules of CTS acupoint selection and combinations for future research and clinical practice. The purpose of this study is to study the correlation rules of acupoints based on data mining, and provide a relatively standard treatment guide for the application of CTS acupoints.

## Methods and Analysis

### Search Methods

We will search both Chinese and English electronic libraries, from their inception to March 2023, including PubMed, Embase, Cochrane Library, China National Knowledge Infrastructure (CNKI), Wanfang Database, Chinese Biomedical Literature Database (CBM) and Chongqing VIP Database (VIP). The language is limited to Chinese and English. Search terms used in our review will be a combination of medical subject heading terms and free-text terms. Search strategies take PubMed as an example, which is shown in [Box 1](#). Based on the characteristics of each database, this search strategy will be adjusted to individual database constraints.

### Review Process

#### Data Screening

The inclusion criteria included: (1) studies reporting on the use of acupuncture therapy as a primary intervention, with or without randomized and/or controlled methods. (2) The number of patients in each group/trial must exceed ten. (3) The patient was diagnosed with CTS according to the diagnostic criteria. (4) Either special acupoints or conventional meridian acupoints have to be used for needle insertion and/or moxibustion. It was either used alone or in conjunction with other interventions to use acupuncture and/or moxibustion (eg, Chinese herbs). (5) Studies comparing various acupuncture techniques for CTS will be included.

In terms of exclusion criteria, the following papers will be excluded: (1) reviews, protocols, animal trials, case reports, systematic reviews, and meta-analyses. (2) Acupuncture for CTS postoperative rehabilitation. (3) Trials of microacupuncture systems, ear needle, head needle, wrist and ankle needle and other non-body needle will be excluded

#### Box 1 Search Strategy for PubMed Database

No.	Search Terms
#1	MeSH terms: "carpal tunnel syndrome"
#2	Title/Abstract: "carpal tunnel syndrome" OR "syndrome, carpal tunnel" OR "carpal tunnel stenosis" OR "mouse hand" OR "CTS"
#3	#1 OR #2
#4	MeSH terms: "acupuncture therapy" OR "acupuncture" OR "cupping therapy" OR "bloodletting"
#5	Title/Abstract: "needling" OR "needles" OR "needle" OR "pricking blood" OR "blood-letting" OR "bloodletting" OR "cupping" OR "fire acupuncture" OR "warm needling" OR "electro-acupuncture" OR "body acupuncture" OR "electroacupuncture" OR "manual acupuncture" OR "acupuncture" OR "acupuncture therapy" OR "cupping therapy"
#6	#4 OR #5
#7	#3 AND #6

since their theoretical underpinnings had no application to conventional acupoints. (4) Trials that solely reported physiological or lab information will be excluded. (5) If acupuncture therapy alone or in combination resulted in less benefits for patients than control group, the study will be excluded. (6) The acupoints prescription in the study was incomplete or even not given will be excluded.

### Data Collection

Furui Miao will evaluate all the titles and abstracts found by the literature search and remove any that are obviously irrelevant (eg, studies focusing on reviews, animal trials, case reports, and so on). The remaining references' full texts will be collected, and they will be once more vetted to remove publications that are not relevant. Fangzhi Zhang and Cai He then will formally evaluate the eligibility of all other papers in accordance with the aforementioned inclusion criteria. Discussions will be used to settle disagreements.

### Database Establishment and Data Normalization Processing

The document manager Endnote×9.2 will receive the imported literature from the search. The literature will be independently reviewed and rescreened by two research members in accordance with the inclusion and exclusion criteria after the duplicated literature will be removed by software, and the results will be checked to guarantee the accuracy of the included literature. The flow diagram (Figure 1) will be used to show the research screening process.

The extracted data will be input into Excel 2019 to establish the acupuncture treatment CTS prescription database. Valid prescriptions will be extracted via the “a group of primary acupoints and a group of secondary acupoints constitute an acupoint prescription” strategy.<sup>14</sup> Referring to the “Study of Meridians and Collaterals”,<sup>16</sup> we will standardize the

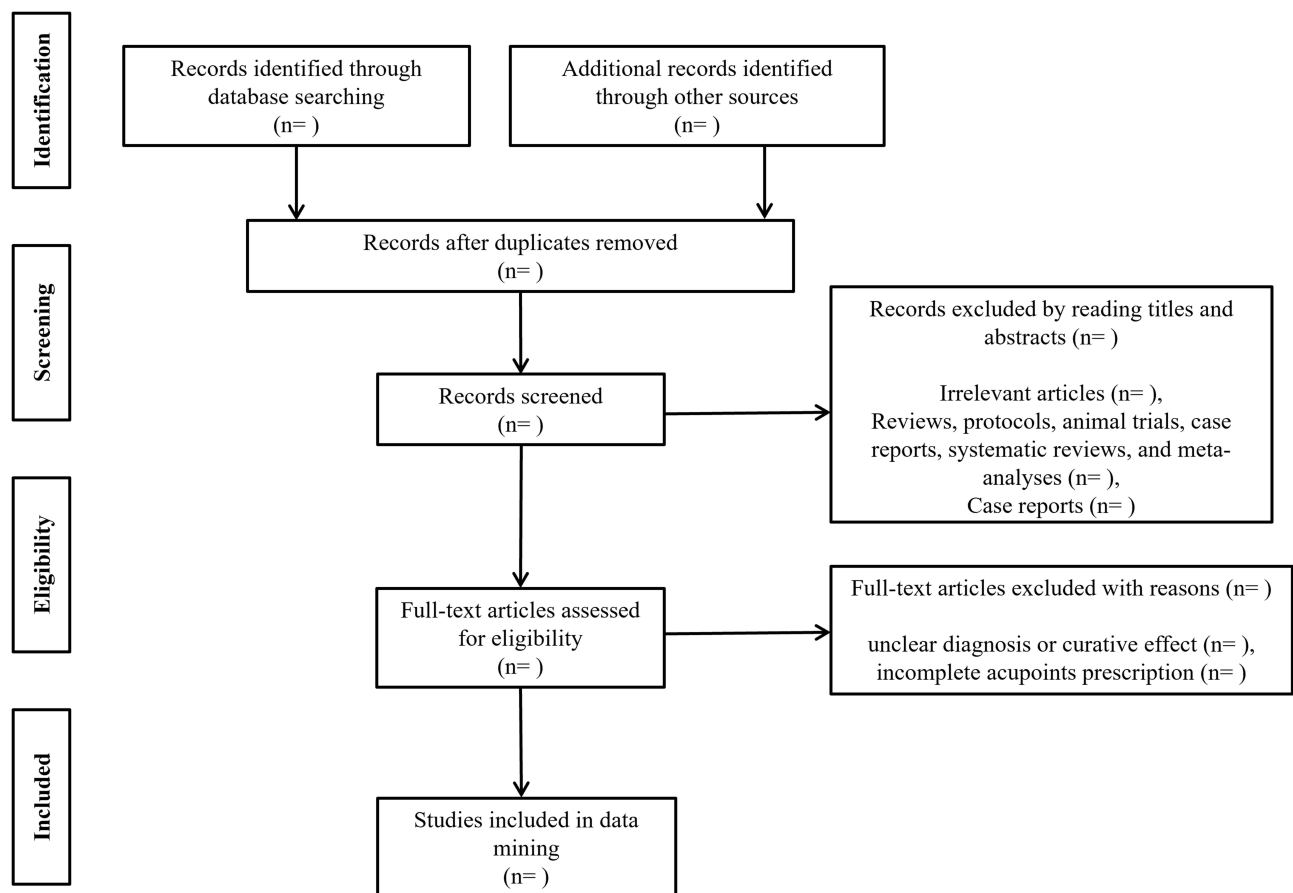


Figure 1 Flow diagram of the study selection process.

names of the acupoints included in the literature, and supplemented the attribution of meridians, site of the points, and the attribution of specific acupoints.

### Managing Missing Data

In order to assess the data on an intention-to-treat basis, we will get in touch with the original authors, who will then provide any missing information. We will only evaluate the data that is currently accessible if detailed information is not available in this manner.

## Data Analysis

### Literature Quality Evaluation

Two reviewers (Yujun He and Cai He) will use the “risk of bias” tool from The Cochrane Collaboration tool to assess the risk of bias in the included studies.<sup>17</sup> The following aspects will be independently evaluated by two researchers: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other bias. Disagreements will be resolved through discussion or negotiation with a third researcher.

### Descriptive Statistics

All of the acupoint prescriptions from the included literature will be loaded into an Excel 2019 table, which will then be used to create a PivotTable to perform descriptive statistical analysis on the frequency of usage of acupoints, the attribution of meridians, site of points, and the attribution of specific acupoints (Boxes 2–5). The acupoints of high-frequency will also be represented by bar charts (Figure 2).

**Box 2** Frequency of Acupoint Application for CTS Treatment

NO.	Acupoint	Frequency (%)

**Box 3** Frequency of Meridian Application for CTS Treatment

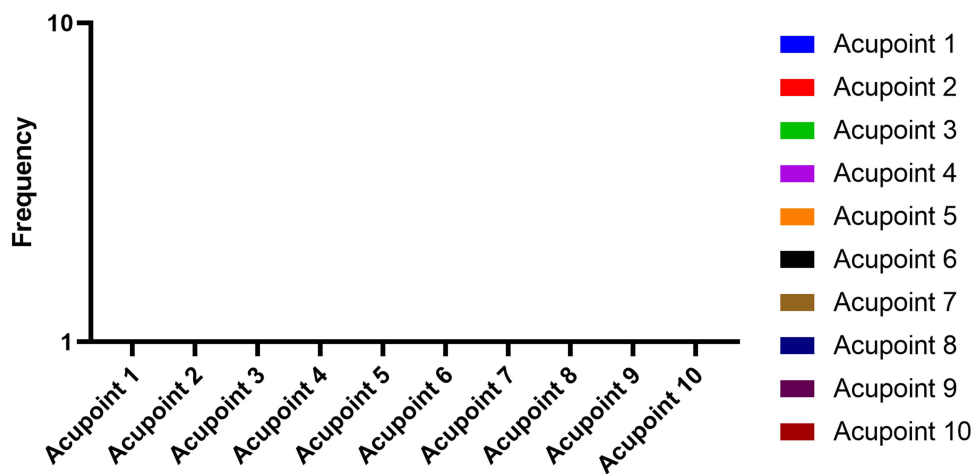
Meridian	Frequency (%)	Amount (%)	Acupoints

**Box 4** Frequency of Site of Points Application for CTS Treatment

Site of Points	Frequency (%)	Amount (%)	Acupoints

**Box 5** Frequency of Specific Point for CTS Treatment

Specific Point	Frequency (%)	Amount (%)	Acupoints



**Figure 2** High-frequency of acupoint application for CTS treatment.

### Association Rule Analysis

SPSS Modeler 18.0 software will be used to analyze the association rules of high-frequency acupoints with Apriori algorithm. The probability of the occurrence of both the anterior and posterior items will be represented by the degree of support, and the degree of confidence will be the probability of the occurrence of the latter item when the former item appeared. After repeated tests, the best and lowest degree of support and confidence will be set, and the maximum of the former item will be set as 2 (Box 6). Then, the complex network diagram will be drawn to analyze the correlation among the acupoints.

### Exploratory Factor Analysis

SPSS Statistics 26.0 will be used to conduct exploratory factor analysis on high-frequency acupoints, and KMO and Bartlett sphericity tests will be performed on the prescription data. If  $KMO > 0.5$  and  $P < 0.05$ , factor analysis will be carried out, and maximum variance rotation will be selected to extract the principal factor components. If  $KMO < 0.5$  or  $P > 0.05$ , it is not suitable for factor analysis.

### Cluster Analysis

SPSS Statistics 26.0 will be used to perform cluster analysis on the high-frequency acupoints, and the cluster analysis tree will be drawn to analyze the clustering relationship among the acupoints.

## Discussion

CTS is the most common nerve entrapment syndrome of the upper limb.<sup>18</sup> Increased carpal tunnel pressure is what causes CTS, but the exact reason is unknown.<sup>19</sup> The median nerve is compressed in the space between the carpal bones and the flexor retinaculum of the transverse palmar ligament, which is known as the CTS. Numbness, tingling, hand discomfort, muscular atrophy, and weakness are the symptoms of CTS. CTS can occur in all ages, races and occupations.<sup>20</sup> Surgery or noninvasive treatment options are available for CTS.<sup>20</sup> As a form of cautious medicine, the American Society of Orthopaedic Surgeons suggests splints, local steroid injections, ultrasound, and oral corticosteroids.<sup>18,21,22</sup> For those with mild to intermediate CTS, conservative treatment is advised,<sup>2,23</sup> for those who

**Box 6** Association Rules of Acupoints for CTS Treatment

NO.	Latteritem	Formeritem	Frequency	Support (%)	Confidence (%)	Lift

have failed conservative treatment or cases of electrophysiologically severe disease, surgery or a combination of surgery and conservative treatment is advised.<sup>24</sup>

Acupuncture, as an important part of traditional Chinese medicine, is widely used in pain management. Acupuncture has been recommended as a potentially useful treatment for CTS.<sup>25</sup> The effectiveness of acupuncture in treating CTS has been demonstrated in numerous clinical studies, and it has long-lasting curative effects.<sup>26–29</sup> Acupuncture has analgesic effects by stimulating endorphins, serotonin and acetylcholine and by regulating emotional and cognitive processing areas of the brain.<sup>30,31</sup> Acupuncturist usually manipulate needles to stimulate acupoints for “deqi”, a feeling of acupoint soreness, numbness, and heaviness, which is associated with identifiable changes in fMRI signals.<sup>32</sup> However, acupuncturists choose different acupoints based on their own experience and ideas. Thus, there is no agreement on the typical acupoint selection and combinations for the treatment of CTS.

In order to investigate the underlying rules, the data mining technology will be performed, which is a promising and practical approach. Data mining technology establishes the associations between each piece of data, counts the frequency of each item in the database, and locates associations with other things.<sup>33</sup> Data mining technology makes it clear what things are the most relative. By using descriptive statistical analysis, we can find out which acupoints, meridians, specific points and sites are commonly used in the treatment of CTS by acupuncture. Association rule mining is an unsupervised machine learning method proposed by Agrawal et al.<sup>34</sup> Apriori algorithm is one of the association rule algorithms, which can adjust the size of frequent set according to its characteristics and finally generate frequent item set. Apriori algorithm has the function of type variable, and can obtain different association results according to the support degree, confidence degree and the value of the preceding item under different conditions. Support degree represents the universality of a certain rule, and confidence degree represents the credibility of this rule. Both of them are important components of association rules. That is, the support degree of association rules in this study refers to the probability that two acupoints are used at the same time, while the confidence degree refers to the probability that acupoint X is used at the same time as acupoint Y.<sup>12</sup> Clustering analysis is a widely used tool for knowledge discovery.<sup>35</sup> It is a method of multivariate analysis that divides samples into categories.<sup>36</sup> Cluster analysis is crucial since it can be used to find population structure, which is frequently utilized in multi-parameter data analysis.<sup>37</sup> It may display the internal structure of data and categorize the results of independent observations based on how similar the internal structure is.<sup>38</sup> Charles Spearman proposed exploratory factor analysis in 1904. It was created using a technique called Varimax Rotation Major Components.<sup>39</sup> Its fundamental tenet is that several sets of observed variables with high correlation and semantic overlap can be combined into a small number of potentially independent factors using dimensionality reduction in multivariate statistical analysis. Exploratory factor analysis is helpful for determining how many variables make up a construct.<sup>40</sup> Our proposed methodology will find the most effective acupoint selection and combinations for CTS, which can provide evidence-based medicine for clinical evidence.

## Conclusion

Our findings will provide evidence for the effectiveness and potential treatment prescriptions of acupoint application for patients with CTS, helping clinicians and patients make a more informed decision together.

## Patient and Public Involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.



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## Disclosure

The authors report no conflicts of interest in this work.

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